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# Ocean Surface Current Anomaly during Titli Cyclone

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***Abstract*: Flow of water in a specific direction in the ocean is known as the ocean current. Winds over the ocean are the one of the key forcing parameter for surface ocean currents. Transfer of energy takes place from the wind to ocean while wind blows over the ocean surface as wind stress which is force of the wind parallel to the surface exerted on the sea surface .This amount of energy depends on wind speed. The typical wind speeds corresponding surface current speed is analyzed using the Grid Analysis and Display Systems (GrADS) during Titli cyclone. Velocity anomalies were observed between 0.2 to 0.5 m/s.**

***Keywords*: Forcing parameter, Wind stress, Surface current**

## 1. Introduction

The surface current are of ocean are play a key role in the heat distribution throughout the ocean in turn effect on the climate. The main cause of the surface currents are winds. Direction of current is effected by not only the Earth rotation known as Coriolis parameter which deflects the current to right to the motion in northern hemisphere and to the left in the southern hemisphere but also altered by the presence of continents and islands. Generally the surface current speed increases as the wind speed increases up to some extent due to increase in wind stress [2] and calculated as

$$\tau = \rho C_D W^2$$

Zonal and Meridional wind stress components are computed as:

$$\boldsymbol{\tau_x} = \rho_{air} C_D W^2 \sin\theta \qquad \boldsymbol{\tau_y} = \rho_{air} C_D W^2 \cos\theta$$

Where,

$\rho$ is the density of air (1.2 kg/m3).
$C_D$ is a dimensionless coefficient called drag-coefficient
W is the wind speed.
$\theta$ is the angle of the wind vector from true north.

Upper layer ocean currents are driven by wind stress which in turn winds speed. Currents which changes its direction according to the prevailing wind pattern is known as seasonal currents. East Indian Costal current (EIC) flow toward north along East Coast of India (ECI) during south west monsoon and flow toward south during the north east monsoon.

During the tropical cyclones typical maximum sustained wind speeds are more than the 119km/h. Titli cyclone formed over the Bay of Bengal which is active period of October 7-13, 2018 in peak stage with 165km/h.

The ocean current said to be geostrophic current when the coriolis force acting on moving water is balanced by the horizontal pressure gradient force. Geostrophic current velocity (u) is determined by slope of a constant pressure surface relative to a surface of constant geopotential known as geopotential surface [3].

$$u = \frac{g}{f} \tan\theta$$

Where

f is Coriolis parameter
$g$ is the acceleration due to gravity
$\theta$ angle made by sea surface with horizontal

Anomaly is the deviation from the normal. Ocean surface current anomalies are calculated as,

Anomaly = actual value – average value

If the anomaly is positive then current speed is more than the normal speed and vice versa

## 2. Analysis of surface current

### *A. Cyclone Track and wind speed up to land fall*

Depression formed over the Bay of Bengal on 8th October, 2018 strengthened and turned into very severe cyclonic storm on 9th October. Titli land fall between the north Andrapradesh and South Odisa coast near Palasa ($18.8^0$N and $84.4^0$E)11th October during 0430-0530 IST [4]. Fig. 1 Titli cyclone track drawn using GrADS up to land fall. Fig.2 and fig.3 drawn based on NCAR/NCAP Real analysis surface wind dataset [5] (Network Common Data Form- NetCDF) using GrADS in which the wind speeds are increasing from 9th October range of 150 kilometer per hour (kmph) to 165 kmph during land fall.

### *B. Anomaly of surface current*

On average, the maximum current speed along the ECI varies from 0.2 to 0.5m/s (Mishra, 2010; Mishra, 2011; Panigrahi et al., 2010). From Fig. 4 to Fig. 6 drawn from the Live Access Server daily mean surface current dataset [6] (NetCDF) using the GrADS [7]. Fig.4 and Fig. 5 are anomalies of zonal component of geostrophic velocities of the

surface current system which has increased on and average maximum deviation is 0.2 to nearly 0.4m/s from 9th October to 11th October as per the wind pattern. Fig. 6 and Fig. 7 are anomalies of meridional component of geostrophic velocities of the surface current system which shows the maintaining of the average deviation from 9th October to land fall of cyclone in the range of the 0.5m/s

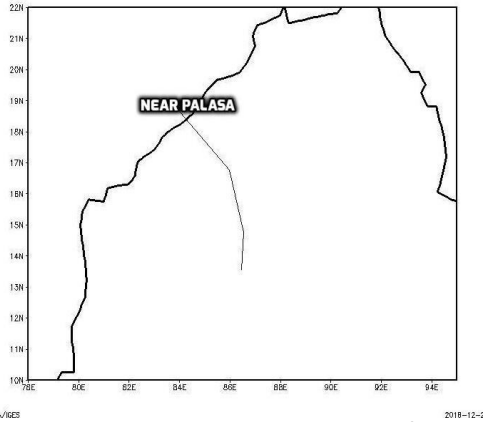


Fig. 1. Titli Cyclone track up to land fall near Palasa on 11thOctober, 2018

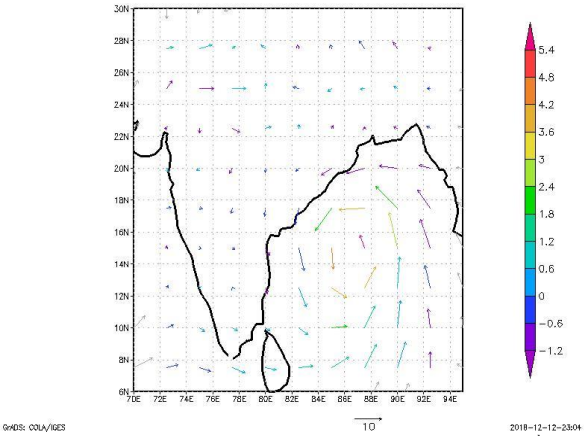

Fig. 2. Wind speed in m/s (color) direction of wind (vectors) on 9th October 2018

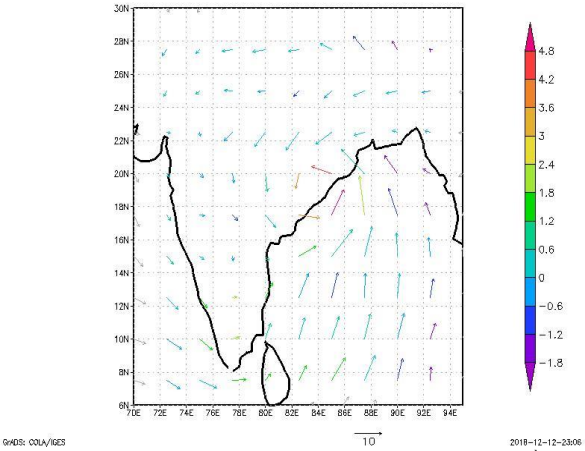

Fig. 3. Wind speed m/s (color) direction of wind (vectors) on 11th October 2018

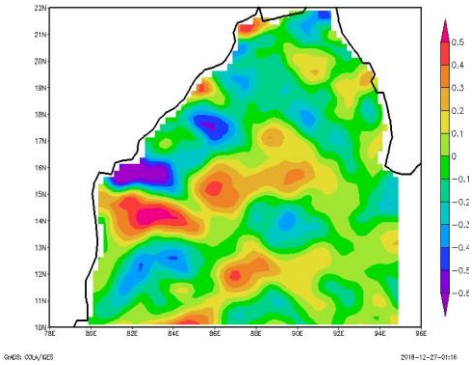

Fig. 4. Zonal component geostrophic velocity anomalies (in m/s) of on 9th October, 2018

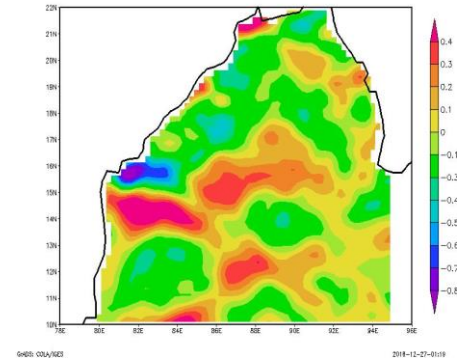

Fig. 5. Zonal component of geostrophic velocity anomalies (in m/s) on 11th October, 2018

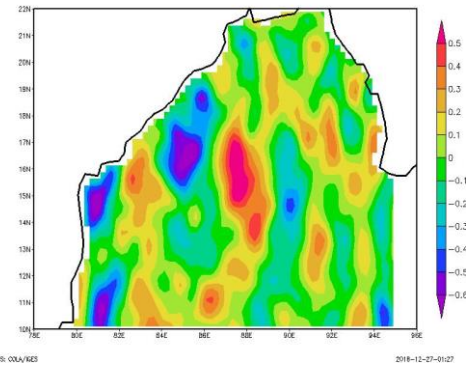

Fig. 6. Meridional component geostrophic velocity anomalies (in m/s) on 9thOctober, 2018

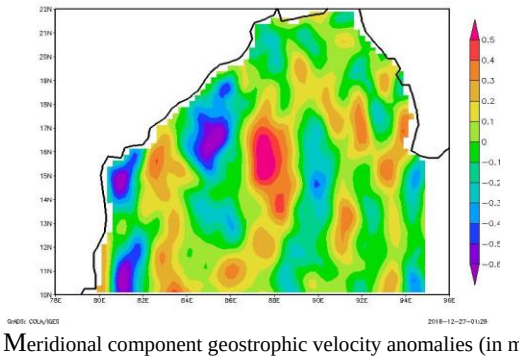

Fig. 7. Meridional component geostrophic velocity anomalies (in m/s) on 11th October, 2018

## 3. Conclusions

Track of the Title cyclone drawn up to land fall, wind pattern and corresponding surface ocean current anomalies were observes using the GrADS which show the nearly increasing with wind speed and maintain almost constant deviation even wind speed increased meridional component of the surface current anomaly.

## References

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